APPENDIX C

This appendix contains a glossary of terms relevant to loran and loran radio
navigation. Sources from which these definitions were taken include Bowditch,
the United States Coast Guard Auxiliary text, Advanced Coastal Navigation, the
Federal Radionavigation Plan, Specification of the Transmitted Loran-C Signal,
Radionavigation Systems (1988), Radio navigation Bulletin, and from course notes
for the Loran-C course taught at the United States Coast Guard Academy (USCGA).

Terms included all relate to loran and/or navigation. Some arguably relevant
terms, such as CALOC, TINO, COCO, PGEN and the like have been deliberately
excluded as this a publication intended for a more general audience. Additional
system-related terms can be found in the USCGA course notes.

Accuracy.

In navigation, the accuracy of an estimated or measured position of a craft
(vehicle, aircraft, or vessel) at a given time is the degree of conformance of
the position with the true position of the craft at that time. Since accuracy is
a statistical measure of performance, a statement of the accuracy of a
navigation system is meaningless unless is includes a statement of the
associated statistical confidence. See also Accuracy: Types.

Accuracy: Statistical Measures.

Navigation system errors generally follow a known error distribution. Therefore,
the uncertainty in position can be expressed as the probability that the error
will not exceed a certain amount. A thorough treatment of errors is complicated
by the fact that the total error is comprised of errors caused by instability of
the transmitted signal, effects of weather and other physical changes in the
propagation medium, errors in the receiving equipment, and errors introduced by
the human navigator. In specifying or describing the accuracy of a system, the
human errors are usually excluded.

When specifying linear accuracy, or when it is necessary to specify requirements
in terms of orthogonal axes (e.g., along-track or cross-track), the 95 percent
confidence level is normally used. Vertical or bearing accuracies will be
specified in one-dimensional terms (2 sigma), 95 percent confidence level.

When two-dimensional accuracies are used, as in the case of Loran-C, the 2 drms
(distance root mean square) uncertainty estimate will be used. Two drms is twice
the radial error, drms. The radial error is defined as the root-mean-square
value of the distances from the true location point of the position fixes in a
collection of measurement. It is often found by first defining an arbitrarily-
oriented set of perpendicular axes, with the origin at the true location point.
The variances around each axis are then found, summed, and the square root
computed. When the distribution of errors is elliptical, as it often is for
stationary, ground-based systems (including Loran-C), these axes can be taken
for convenience as the major and minor axes of the error ellipse. Then the
confidence level depends on the elongation of the error ellipse. As the error
ellipse collapses to a line, the confidence level of the 2 drms measurement
approaches 95 percent; as the error ellipse becomes circular, the confidence
level approaches 98 percent.

DOD specifies horizontal accuracy in terms of circular error probable (CEP the radius of a circle containing 50 percent of all possible fixes) or spherical error probable (SEP) the radius of a sphere containing 50% of all possible fixes.

Accuracy: Types.

Specifications of radio navigation system accuracy generally refer to one or more of the following definitions:

Predictable accuracy: the accuracy of a position with respect to the geographic, or geodetic, coordinates of the earth. (Also called absolute or geodetic accuracy.)

Repeatable accuracy: the accuracy with which a user can return to a position whose coordinates have been measured at a previous time with the same navigation system.

Relative accuracy: the accuracy with which a user can measure position relative to that of another user of the same navigation system at the same time. This may be expressed also as a function of the distance between the two users. Relative accuracy may also refer to the accuracy with which users can measure position relative to their own positions in the recent past. For example, the present position of a craft whose desired track forms a specific geometric pattern in search operations or hydrographic survey, will be measured generally with respect to a previously determined datum.

Acquisition.

The reception and identification of transmitted Loran-C signals from master and selected secondaries to permit reliable measurement of TDs. The requisite signal-to-noise ratio for original signal acquisition is generally greater than for tracking.

Additional Secondary Factors (ASFs).
 Land path factors due to variation in the conductivity of the earth's surface that alter the speed of propagation of loran signals over land compared to over water. Variation of propagation velocities over land degrade the absolute accuracy of a loran system (unless compensated for) but do not affect the repeatable accuracy.

Aid to Navigation (ATON or NAVAID).
 Any device external to a vessel or aircraft specifically intended to assist navigators in determining their position or safe course, or to warn them of dangers or obstructions to navigation.

Allowable GRIs.
 As published in the Federal Register (40Federal Register 29, 11 February 1975), permissible GRIs are multiples of 10 microseconds from 40,000 through 99,990 microseconds.

Ambiguity.
 In certain areas, particularly in the vicinity of loran baseline extensions, there is the possibility that two positions will satisfy two observed loran TDs.

Anchor Alarm.
 Feature of many Loran-C receivers that can be set to warn the user that the
vessel has moved outside the swing circle of the anchor. This is also termed an
anchor watch.

Angle of Cut.
 The smaller angular difference between two bearings or lines of position. See
also Crossing Angle.

Antenna.
 Any structure or device used to collect or radiate electromagnetic waves;
specifically, that part of a transmitter or receiver that contains, or itself
consists of, the apparatus that radiates or receives electromagnetic waves.

Antenna Coupler.
 A radio frequency transformer and other electronic circuit(s) used to connect
an antenna to a transmission line or to connect a transmission line to a radio
receiver. The purpose of an antenna coupler is to match the impedance of the
antenna with the receiver. In practical terms, an antenna coupler enables the
use of physically short antennas.

Arrival Alarm.
 Feature of many Loran-C receivers that provides an aural warning when the
vessel is within a certain distance of a specified waypoint along a route. The
distance at which the alarm is activated is typically adjustable.

Attenuation.
 A lessening in amount, particularly the reduction in amplitude of an
electromagnetic wave with distance from the origin.

Automated Notices to Mariners System (ANMS).
 Computer system that can be accessed by authorized users to obtain chart
corrections and notices to mariners. Users need a teletype, computer terminal,
or other device, and an access code available from DMA.

Automatic Secondary Selection (ASS).See Automatic Transmitter Selection.

Automatic Transmitter Selection (ATS) .Feature on some Loran-C receivers that
automatically selects the master and secondaries to use for position
determination. Criteria for selection of secondaries differ among makes and
models of receivers, and involve crossing angles, gradients, and SNR. When a
receiver equipped with this feature is initialized or set up, the user enters an
approximate position (in latitude and longitude) and the receiver selects the
chain and secondaries associated with this approximate position and the SNRs of
the secondaries.

Autopilot.
 Device for automatic steering of a vessel. Depending upon the Sophistication of
the autopilot, these can be used to maintain a heading, or to interface with a
loran or other electronic navigation system. Sometimes informally called George
or Iron Mike.

Availability.
 The availability of a navigation system is the percentage of time that a signal
within preestablished tolerances is being broadcast throughout the coverage
area. Availability is an indication of the ability of the system to provide
usable service within the specified coverage area. Signal availability is the

percentage of time that navigational signals transmitted from external sources are available for use. It is a function of both the physical characteristics of the environment and the technical capabilities of the transmitter facilities. For example, the measured availability of the Loran-C chain in the eastern U. S. and Canada have averaged 99.8786% availability over the last decade.

Baseline.
 The shortest-distance segment of a great circle that joins the master and a secondary station in a loran chain. Also used to describe a master secondary pair.

Baseline Delay.
  Same as baseline travel time.

Baseline Extension.
  The extension of the baseline beyond the two joined stations. Loran positions in baseline extension areas are problematic and ambiguous.

Baseline Length.
 Same as baseline travel time when expressed in usec.

Baseline Travel Time.
 The length of time, in microseconds, that it takes for a loran signal to travel along the baseline from the master to a secondary station.

Blink.
 An indication that the master or secondary signals in a loran chain are out of tolerance and not be used. Loran receivers have a blink alarm that warns the user that the indicated positions may not be reliable. Blink conditions warn that the signal power or TD is out-of-tolerance (OOT) and/or that an improper phase code or GRI is being transmitted. Physically (see Chapter II) the first two pulses of the secondary pulse group are blinked on and off. In turn, the receiver displays this blink code by flashing the display. Blink contributes to the integrity of the Loran-C system. According to some sources, this code is the origin of the common English phrase
on the blink.
 There are actually two types of blink, secondary and master blink. See the main text.

Centerline.
 Perpendicular bisector (great circle) of the baseline. This represents the locus of points equidistant from both master and secondary.

Chart Reference Systems Nautical Charts.
  Most nautical charts are based on regional horizontal datums which have been defined over the years independently of each other. These include charts published by the Defense Mapping Agency and the National Ocean Service of NOAA. In addition, in many parts of the world, the positional accuracy of chart features (such as hazards to navigation) sometimes varies from chart to chart and in some cases, within a chart. Certain charts for waters in the Southern Hemisphere, for example, do not show islands in their correct geodetic positions, absolute or relative. Therefore, datums and limited chart accuracy must be considered when a navigational fix is plotted by a navigator on a nautical chart.

Modern navigational positioning is based on satellite systems which are geocentric by definition, and these satellite coordinate systems differ

significantly in many cases with the local or regional datums of nautical charts. In addition to this difference, the plotted details such as soundings and navigational aids contain a minimum plottable error that ranges between 0.5 mm to 1.0 mm on paper.

Virtually all radionavigation equipment incorporating coordinate converters (automated computation of geodetic latitude and longitude from data received from a radionavigation system) are programmed with the World Geodetic System 1972 (WGS 72) description of the earth. In January 1987, GPS began using WGS 84, an improvement over WGS 72. There are significant variations between WGS 72 and WGS 84 coordinates and coordinates referenced to local datums. These differences range from a few meters in the central US to 160 meters in Alaska and the Caribbean, and almost 450 meters in Hawaii.

The large majority (86 percent) of the nautical charts published by NOS have been compiled on a regional horizontal datum, specifically, the North American Datum of 1927 (NAD 27). The remaining 14 percent of the charts in the NOS nautical chart suite have been published on eight other local or regional datums. NOS has adopted a geocentric datum, NAD 83, and is beginning to convert its suite of nautical charts to that datum. The charts of the Pacific Islands published by NOS will be compiled on WGS 84. For charting purposes, however, NAD 83 is equivalent to WGS 84. As charts are converted, datum transformation notes will be added which report the extent of the shift from NAD 27 coordinates.

Improvements in worldwide navigational accuracy, which are anticipated with the implementation of GPS in the early 1990s, will be significant. However, the ability to safely navigation along the coastlines of the world and on the high seas will remain limited where accurate, up-to-date hydrography and associated topographic features are not all positioned on the same satellite-based WGS reference system.

Chart Reference Systems.
 Geodetic datums are basic control networks used to establish the precise geographic position and elevation of features on the surface of the earth. They are established at all levels of government (international, national, and local) and form the legal basis for all positioning and navigation. Within the last 20 years, there have been great advances in our knowledge of the shape and size of the earth (i.e., our geodetic knowledge). The old datums are no longer scientifically relevant (although otherwise still relevant). In recent years, geodesy and navigation trended toward earth centered body fixed (ECBF) coordinate systems. These are Cartesian coordinate systems with origins at the center of mass of the earth, whereas the old datums have generally been based on localized surface monumentations (and associated agreements) and defined by a reference ellipsoid that was not earth centered.

The DOD Global Positioning System is based on the World Geodetic System of 1984 (WGS 84). WGS 84 is an ECBF coordinate system upon which all US military and much civilian navigation, geodesy, and survey will be based. Within the US, the National Geodetic Survey (NGS) is the legal authority for the establishment of US datums. The datum presently used throughout most of the US and Canada is the North American Datum of 1927 (NAD 27). This is a surface (or horizontal) datum. There is a vertical datum as well (i.e., the National Geodetic Vertical Datum [NGVD 29]). Practically all nautical charts, aeronautical charts, federal surveys, and associated data provided by the National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA) are legally established with respect to NAD 27. Recently, NGS has developed a new datum known as the North American Datum of 1983 (NAD 83) which, for purposes of navigation and

relative survey, is generally the same as WGS 84. NAD 83 is based on the internationally adopted earth model GRS 80; the WGS 84 earth model differs slightly from GRS 80. The NGS is presently completing a new vertical datum (NGVD 88).

Circular Error Probable (CEP).
 In a circular normal distribution (the magnitudes of the two one-dimensional input errors are equal and the angle of cut is 90), circular error probable is the radius of the circle containing 50 percent of the individual measurements being made, or the radius of the circle inside of which there is a 50 percent probability of being located.

Coastal Confluence Zone (CCZ).
 Harbor entrance to 50 nautical miles offshore or the edge of the Continental Shelf (100 fathom curve), whichever is greater.

Common-use Systems.
 Systems used by both civil and military sectors.

Conterminous U.S.
 Forty-eight adjoining states and the District of Columbia.

Control Station.
 Station to record information sent by LORMONSITES, determine whether or not any signals are out-of-tolerance, insert corrections to the transmitting stations, and notify the user of any abnormalities via blink. Out-of-tolerance conditions are relayed from the control station to the transmitting stations. In most cases control stations are located in the same facility as the LORSTA.

Coordinate Conversion.
 The process of changing the coordinate values from one system to another; e.g., from geodetic coordinates (latitude and longitude) to Universal Transverse Mercator grid coordinates, or in the case of Loran-C, from Time Differences to geodetic coordinates. In the case of Loran-C, conversion can be a manual process, by interpolation of LOPs printed on nautical or aeronautical charts, or accomplished automatically in the Loran-C receiver.

Course (C).
 Course is the average heading and the horizontal direction in which a vessel is intended to be steered, expressed as the angular distance relative to north, usually from 000 at north, clockwise through 359 from the point of departure or start of the course to the point of arrival or other point of intended location.

Course Deviation Indicator (CDI).
 An indicator, shown on some lorans, that graphically displays whether or not the vessel is on the designated track between waypoints and, if not, the direction to return to this track.

Course LOP.
 An LOP situated approximately directly ahead or behind the vessel, so named because the LOP provides a good indication of the vessels CMG.

Course Made Good (CMG).
 This indicates the single resultant direction from a point of departure to a point of arrival at a given time. (Synonym: Track Made Good)

Course of Advance (COA).

This indicates the direction of the intended path to be made good over the ground.

Course Over the Ground (COG).
 This indicates the direction of the path actually followed by the vessel over the ground, usually an irregular line.

Coverage Area.
 The coverage provided by a radionavigation system is that surface area or space volume in which the signals are adequate to permit the navigator to determine position to a specified level of accuracy and at a specified SNR. Coverage is influenced by system geometry, signal power levels, receiver sensitivity, atmospheric noise conditions, and other factors which affect signal propagation.

Coverage Diagram.
 A diagram showing the area where a given loran chain enables reliable reception (at an acceptable SNR) and satisfies specified accuracy criteria. Coverage diagrams are provided for each Loran-C chain elsewhere in this document.

Cross Rate (Cross Chain) Interference.
 Interference in the reception of radio signals from one loran chain caused by signals from another loran chain.

Cross Track Error.
 Distance between the vessels actual position and the direct course between two waypoints. Abbreviated XTE on some receiver displays.

Cross Track Error Alarm.
 Alarm that can be set on many Loran-C receivers that warns the navigator if the vessels cross track error exceeds some prespecified value.

Crossing Angle.
 Generally, the smaller of the angles between two LOPs which determine a fix. The closer this angle is to 90 degrees, the better the fix. Also used with loran LOPs.

Current.
 Term used in two senses. It is used to refer either to the horizontal motion over the ground, including ocean current, tidal, and river currents, or more generally to these factors together with the effect of wind and seas, steering error of the helmsman, compass error, speed curve error, and other factors.

Current (alternate definition).
 Generally, a horizontal movement of water. Currents may be classified as tidal and nontidal. Tidal currents are caused by gravitation¬al interactions between the sun, moon, and earth and are a part of the same general movement of the sea that is manifested in the vertical rise and fall, calledtide. Nontidal currents include the permanent currents in the general circulatory systems of the sea as well as temporary currents arising from more pronounced meteorological variability.

Cyclan.
 The designation of Loran-C in the earliest stage of development, later superseded by the term Cytac.

Cycle Match.

In Loran-C, the comparison, in time difference, between correspond¬ing carrier cycles contained in the times of a master and secondary station pulse. The comparison is refined to a determi¬nation of the phase difference between these two cycles. Cycle matching provides superior performance over enve¬lope matching.

Cycle Slip.
 Failure of the Loran-C receiver to lock on the proper sampling or tracking point. In cases of cycle slip, the receiver will lock on to another sampling point that differs from the proper sampling point by integer multiples of 10 microseconds. This is most likely to occur in fringe areas outside the normal Loran-C coverage area, but can occur elsewhere in the coverage area. Unless recognized and compensated for, cycle slip will result in additional errors of position. F position errors are detected and are the result of cycle slip, these can be compensated for by manual cycle selection or cycle step. Cycle slip can be detected by cross-checking loran positions with other methods, and also by noting the SNR for the signal. Cycle slippage further into the loran pulse will increase the SNR.

Cycle Step.
 A manual mode of altering the sampling point of the signal, in 10 microsecond increments. This may need to be done to attempt to correct cycle slip and/or to find a stronger portion of the signal for fringe area operations. Stepping further into the loran signal will increase the signal strength, but also increases the likelihood of skywave contamination.

Cytac.
 The designation of Loran-C in an earlier stage of development.

Dead Reckoning (DR).
 The practice of estimating position by advancing a known position for courses and distances run. The effects of wind and current are not considered in determining a position by dead reckoning.

Dead Reckoning (DR) Plot.
 A DR plot is the charted movement of a vessel as determined by dead reckoning.

Dead Reckoning (DR) Position.
 A position determined by dead reckoning.

Differential.
 A technique used to improve radionavigation system accuracy by determining positioning error at a known location and subsequently transmitting the determined error, or correction factors, to users of the same radio navigation system, operating in the same area.

Differential Loran.
 A system to increase the accuracy of loran which operates by broadcasting a correction signal to users in a fixed geographic area to adjust measured TDs to compensate for seasonal, diurnal, chain control, transmitter, and other effects. Differential loran has proven feasible in tests by the Coast Guard (see bibliography), but has not been implemented.
Direction (True).
 The angle between the local true meridian and a line from the observer's position to an object or another location.

Distance-to-Go (DTG).

Quantity displayed on some loran receivers representing the distance from the vessel's (or aircraft's) present position to the next waypoint.

Dividers.
 An instrument consisting of two pointed legs joined by a pivot, and used principally for measuring distances or coordinates. An instrument having one pointed leg and the other carrying a pen or pencil is called a drafting compass.

Drift.
 The speed in knots at which the current is moving. Drift may also be indicated in statute miles per hour in some areas, the Great Lakes, for example. This term is also commonly used to mean the speed at which a vessel deviates from the course steered due to the combined effects of external forces such as wind and current. With external inputs, such as a fluxgate compass and a device to measure speed through the water, some Loran-C receivers can determine current set and drift.

Dual Rate Blanking.
 To provide continuous service from one Loran-C chain to the next, some stations are dual rated (see dual rated station). A dual-rated station is faced periodically with an impossible requirement to radiate two overlapping pulse groups at the same time. During the time of overlap, the subordinate signal is blanked or suppressed. Priority blanking occurs when the same rate is always blanked, whereas alternate blanking occurs whenever the two rates are blanked in an alternate manner.

Dual Rated Station. Term used to describe a master or secondary station in one Loran-C chain that is also used as a master or secondary in another chain. The Dana, Indiana, loran transmitter is one example, serving as the Zulu secondary in the 9960 (Northeast US) chain as well as the master in the 8970 (Great lakes) chain.

ECBF. See definition of chart reference systems.

Electronic Chart.
 A device that can display a chart like representation on a screen. Some electronic charts are very elaborate and allow the user to zoom in

 to examine an area at a larger scale. Depth contours, NAVAIDS, and other chart features can be displayed even down to individual docks at certain locations. Electronic charts can interface with other shipboard electronics, such as a loran and display the vessels current position, waypoints, and related information.

Electronic Navigation Digital Data System (ENDDS).Computer system used by DMAHTC which, inter alia, computes ASFs.

Emission Delay (ED).
 The time difference, in microseconds, between when a master loran station transmits and a given secondary station transmits. The emissions delay (ED) is equal to the sum of the baseline travel time plus the secondary coding delay.

Envelope Match.
 In Loran-C, the comparison, in time difference, between the leading edges of the demodulated and filtered pulses from a master and secondary station. The pulses are superimposed and matched manually or automatically. This may be done

preliminary to a cycle match. The Loran-A system employed envelope matching, but not cycle matching.

Envelope to Cycle Difference (ECD).
 The time relationship between the phase of the Loran-C carrier and the time origin of the envelope waveform. Zero envelope to cycle difference is defined as the signal condition occurring when the 30 microsecond point of the Loran-C pulse envelope is in time coincidence with the third positive zero crossing of the 100 kHz carrier.

Envelope to Cycle Discrepancy.
 An error in a Loran-C TD measurement which results from disturbing the precise relationship between the shape of the pulse envelope and the phase of the carrier wave necessary for an accurate measurement.

Estimated Position (EP).
 An improved position based upon the DR position and which may include, among other things, factoring in the effects of current (wind, water currents, etc.), a single line of position, or both of the above.

Estimated Time Enroute. (ETE)
  The estimated time for the vessel to travel from its present position to the next waypoint in sequence. Same as TTG.

Estimated Time of Arrival. (ETA)
 The estimated time that the vessel will arrive at the next waypoint. It is calculated by the loran receiver as present clock time plus the distance to go divided by the vessel's speed (speed over the ground on some models, or velocity made good on other models).

Fix.
 A known position determined by passing close aboard an object of known position or determined by the intersection of two or more lines of position (LOPs) adjusted to a common time, determined from terrestrial, electronic, and/or celestial data. The accuracy, or quality of a fix, is of great importance, especially in coastal waters, and is dependent on a number of factors.

Fix Dimensions.
 This characteristic of a navigation system defines whether the navigation system provides a linear, one-dimensional line-of-position, or a two- or three-dimensional position fix. The ability of the system to derive a fourth dimension (e.g., time) from the navigational signals is also included.

Fix Rate.
 The fix rate is defined as the number of independent position fixes or data points available from the system per unit time.

Fluxgate Compass.
 A compass that senses the earth's magnetic field electronically, rather than with magnets. Fluxgate compasses can interface with other shipboard electronics such as radar or loran.

Fringe Area.
 Region at or beyond the published range and accuracy limits for a loran chain. Attainment of published accuracy limits may be difficult or impossible because of geometric limits or noise. Reception of ground wave signals may be

compromised by skywave contamination in this region. Finally, specialized operating techniques may be required in fringe areas.

Gee.
 British hyperbolic system used for air navigation during World War II. Gee, proposed by R. J. Dippy in 1937 and implemented in early 1942, was a pulsed system operating at frequencies from 30 to 80 megahertz, with separation between transmitters of the order of 100 miles. Gee was named for the hyperbolic grid of TDs.

Geocentric.
 Relative to the earth as a center, measured from the center of the earth.

Geodesy.
 The science related to the determination of the size and shape of the earth (geoid) by such direct measurements as triangulation, leveling, and gravimetric observations; which determines the external gravitational field of the earth and, to a limited degree, the internal structure.

Geodetic Accuracy. Term meaning the same as absolute or predictable accuracy.

Geometric Dilution of Precision (GDOP).
  Term used to include all geometric factors (gradient, crossing angle) that degrade the accuracy of position fixes from externally referenced navigation systems, such as Loran-C. GDOP can be calculated from an equation which summarizes these effects in one single measure.

Global Positioning System (GPS).
 GPS is a spaced-based positioning, velocity and time system that uses satellites for world-wide coverage. (See Chapter I.)

Gradient.
 Mathematically the rate of change of distance with respect to time difference. It is measured as the ratio of the spacing between adjacent loran TDs, as measured in nautical miles, yards, or feet, and the number of microseconds difference between these lines. Most commonly this is expressed as ft/usec or meters/usec. Generally speaking, the smaller the gradient, the better the fix. The loran gradient is smallest along the baseline, where it is numerically equal to 491.62 ft/usec.

Great Circle.
 The intersection of a sphere and a plane through its center.

Great-Circle Distance.
 The length of the shorter arc of the great circle joining two points on a sphere. It is usually expressed in nautical miles (NM).

Grid.
 A series of lines, usually (but not always) straight and parallel, superimposed on a chart or plotting sheet to serve as a directional reference for navigation. Although the term grid could be used to refer to any two or more families of intersecting lines (as in the hyperbolic lines for Gee), a preferred term for hyperbolic systems is lattice.
Ground wave.
 A radio wave that travels near or along the earth's surface.

Group Repetition Interval (GRI).

Length of time (in microseconds) between the start of one transmission from the master station in a Loran-C chain and the start of the next.

GRI Designator.
 This is the GRI of the chain with the last zero omitted. Thus, a chain with a GRI of 99,600 usec would have a GRI designator of 9960. The GRI designator is used to identify a loran chain. The terms GRI and GRI designator are often used interchangeably in casual conversation.

Gyrocompass.
 A compass having one or more gyroscopes as the directive element(s), and which is north seeking. Its operation depends upon four natural phenomena, including gyroscopic inertia, gyroscopic precession, the earth's rotation, and gravity.

Heading (HDG).
 The instantaneous direction of a vessels bow. It is expressed as the angular distance relative to north, usually 000 at north, clockwise through 359. Heading should not be confused with course. Heading is a constantly changing value as a vessel yaws back and forth across the course due to the effects of sea, wind, and steering error. Heading is expressed in degrees of true, magnetic, or compass direction.

Hertz (Hz).
 Name for a derived unit of frequency in the international system of units. One Hertz is equal to one cycle per second.

HF.
 See Chapter I, Table I-3.

Homing.
 Process of moving towards a location by continually pointing the bow of the vessel or nose of the aircraft in the direction of the station. In the absence of wind or current, homing will lead to a ground track that is a straight line. With any current, however, the ground track will become curved, bowed in the direction of the prevailing current.

Hyperbolic Grid.
 Lattice f curved (hyperbolic) lines of position produced by a hyperbolic system.

Hyperbolic System.
 Navigation systems, such as Loran-C or Omega, that operate by measuring the time difference between signals transmitted by two or more transmitters.

Integrity.
 Integrity is the ability of a navigation system to provide timely warnings to users when the system should not be used for navigation. For the Loran-C system, integrity is effected by secondary blink.

Ionosphere.
 The region of the atmosphere extending from about 40 to 250 statute miles above the earths surface, in which there is appreciable ionization. The presence of charged particles in this region affects the propagation of certain electromagnetic radiation.

Jitter.

A term used to describe the short term instability of a signal. This instability may be in amplitude, phase, or both. Used in connection with loran, this is the variation of the last digits (in either TD or latitude/longitude mode) displayed on the loran receiver caused by changing propagation of the signal or other sources.

Kilo.
 Prefix meaning 1,000.

Latitude (L, Lat).
 Angular measure north or south of the equator (typically expressed in degrees from zero to ninety), north or south, e.g., L 073N or as degrees, minutes, and seconds.

Lattice.
 A pattern formed by two or more families of intersecting lines, such as that pattern formed by two or more families of hyperbolas representing curves of equal time difference associated with a hyperbolic radionavigation system. Similar to grid.

LCD Liquid Crystal Display.
 Type of display screen used with loran receivers and other electronic equipment. This display typically shows black (or dark colored) numbers or letters on a white or grey screen. This display is typically easy to see during bright daylight. Most modern loran receivers use this type of display.

LED Light Emitting Diode.
 Type of display screen used with earlier loran receivers and other electronic equipment. This display typically shows red (orange) numbers or letters on a dark background. This display is sometimes difficult to see in bright daylight.

Legend.
 A title or explanation on a chart, diagram, illustration.

Line of Position (LOP).
 A line of bearing to a known origin or reference, upon which a vessel is assumed to be located. An LOP is determined by observation (visual bearing) or measurement (RDF, loran, radar, etc.). An LOP is assumed to be a straight line for visual bearings, or an arc of a circle (radar range), or part of some other curve such as hyperbola (loran).

Line of Sight.
 The straight line between two points. This line is in the direction of a great circle, but does not follow the curvature of the earth. Used also to describe certain radio waves where minimal beveling occurs.

Local Notice to Mariners.
 A written document issued by each U.S. Coast Guard district to disseminate important information affecting aids to navigation, dredging, marine construction, special marine activities, and bridge construction on the waterways within that district. Scheduled Loran-C system outages are published in Local Notice to Mariners.

Locus.
 All possible positions of a point or curve satisfying stated conditions.

Longitude (Lo).

Distance east or west of the prime meridian expressed in degrees from zero to 180 east or west; e.g., Lo 123W, or as degrees, minutes, and seconds.

Loran.
 A contraction of long-range navigation, used to describe an electronic navigation system using a chain of transmitting stations that allows mariners (or aviators) to determine their position. When used in a generic sense, the word loran is not capitalized (except at the beginning of a sentence). When used to denote a specific system (e.g. Loran-C) the word loran is capitalized.

Loran-A.
 Also called standard loran, a forerunner to the present Loran-C system operating in the medium frequency band (1850-1950 kHz) phased out in 1980 in the United States.

Loran-C LOP.
 Line of position as determined from reception of the loran master signal and that of one secondary. Loran-C LOPs at convenient intervals are printed on NOS charts. See also Rate.

Loran-C Overprinted Chart.
 Nautical chart with Loran-C TD LOPs superimposed, used for navigation and coordinate conversion.

Loran-C Plotter.
 A device (typically made of cardboard or plastic) that enables interpolation between charted loran LOPs. Another method of interpolation is printed on loran overprinted charts. See also Loran Linear Interpolator.

Loran-C Signal Availability.
 The design minimum availability for a Loran-C triad is 99.7%, computed on an approximately monthly basis. For purposes of computing availability, a baseline (station pair) is considered unavailable when any of the following conditions exist:

(i) TD out of tolerance,

(ii)ECD out of tolerance,

(iii) Improper phase code or GRI, or

(iv) Master or secondary station off-air or operating at less than 50% of specified power output.

Loran Chain.
 Series of three to six transmitting stations consisting of a master station and two to five secondary stations used in the loran system.

Loran Linear Interpolator.
 A small inset diagram shown on loran overprinted charts that enables interpolation of time differences. Alternatively, a cardboard or plastic card with several overprinted scales used for this same purpose.

Loran Monitor Site (LORMONSITE).Monitor site to observe transmitted signal (signal strength, time difference, LOP, and pulse shape) as received in the coverage area. Formerly termed System Area Monitor (SAM).

Loran Pulse.
 Basic building block of the transmitted loran signal. The loran pulse exhibits
a characteristic (and well controlled) waveform which can be identified and
timed by a receiver. The loran signal from a master station actually consists of
nine pulses. The first eight pulses are spaced 1,000 microseconds apart,
followed at an interval of 2,000 microseconds by the ninth pulse. Secondary
stations transmit only eight pulses, each separated by 1,000 microseconds.
Pulsed transmission saves on the power required for signal transmission and
facilitates signal identification. Multiple-pulse transmission is used rather
than single-pulse transmission to increase the average power of the loran
signal. The appearance of the pulse is discussed elsewhere in this handbook.

Loran Station (LORSTA).Facility housing master or secondary transmitter.

Low Frequency.
 Radio transmissions in the range of 30 to 300 kHz. The Loran-C system is a low-
frequency system.

Magnetic Compass.
 A magnet, balanced so that it can pivot freely in a horizontal plane; a sailors
most common and most reliable direction-indicating aid.

Magnetic Direction (M).
 A direction relative to the earth's magnetic field and magnetic north. Magnetic
courses are labeled with an M to signify magnetic.

Magnetic Meridian.
 A system of meridians passing through the earths magnetic poles. A compass
aligns with these meridians if there is no local magnetic field on the vessel to
cause deviation.

Master Station.
 Essential component of a Loran-C chain. This station broadcasts the signal that
is used to identify the chain (the GRI) and is the common base against which all
time differences are calculated.

Mega-.
 Prefix meaning 1 million.

Mercator Projection.
 The projection technique most commonly used in navigational charts; shapes and
distances are increasingly distorted as you move into extreme northern and
southern areas. This is a cylindrical projection ingeniously modified by
expanding the scale at increase latitudes to preserve ships direction, and
angular relationships.

Meridian (Geographic Meridian).
 A great circle of the earth passing through both the geographic poles and any
given point on the earth's surface.

MF.
 See Chapter I, Table I-3.
Micro-.
 Prefix meaning one millionth.

Microsecond (us or usec).

One millionth of a second.

Most Probable Position.
 Vessels probable position considering all available navigational information.
Term is generally used when there is position uncertainty as a result of
conflicting or ambiguous information.

Nano-.
 Prefix meaning one billionth.

Nanosecond (ns or nsec).
 One billionth of a second.

Nautical Mile (nm).
 A unit of distance used principally in navigation. The international nautical
mile is 1,852 meters long.

Nautical Slide Rule.
 Analog device for solving time-speed-distance calculations. In present
manufacture these are typically circular slide rules with three separate scales
graduated in units of time, speed, and distance.

Navigation.
 The art and science of conducting a vessel or aircraft safely from one point to
another.

North Geographic Pole.
 A reference for specifying a position on the earth's surface, at the north end
of the earth's axis. Also called True North Pole.

North Magnetic Pole.
 The central point of the north end of the earths magnetic core to which a
compass points when it is free of other influences.

Notch Filters.
 Filters in a loran receiver that are either fixed or capable of being tuned to
reduce (notch out) the effects of interfering signals. Some filters (termed
Pac-Man filters) can automatically seek and notch out interfering signals.
Typical signals that can cause loran interference are listed in this Loran-C
Handbook. The notch filters on a loran should be adjusted for the area of
intended cruising to minimize the interference caused by the competing signal.

Out of Tolerance (OOT).
 A condition in which a Loran-C signal or time difference exceeds established
tolerances. An out-of-tolerance (OOT) condition causes the secondary transmitter
to blink.

Paraline Plotter.
 Plotter that has a set of rollers attached to enable the device to be moved
parallel to itself, and used for the same purpose as parallel rules.

Parallel of Latitude.

Any of the imaginary small circles parallel to the equator and representing latitude.

Phase Code Interval (PCI).
 That interval over which the phase code repeats itself. For the Loran-C system, phase codes repeat every two GRIs.

Phase Coding.
 This is a scheme of changing the phase of the pulses in a transmitted loran signal to minimize pulse-to-pulse skywave interference and to reject synchronous interfering signals. Master and secondary transmitters use different phase codes for signal identification. These codes are shown in Chapter II of this handbook.

Phase Velocity.
 Term used to describe the velocity of the leading edge of the Loran-C wave at its point of contact with the earth's surface. This velocity is affected by conductivity and atmospheric effects.

Plotter.
 Device for drawing straight lines on a nautical chart, and measuring courses, bearings, and (with some plotters) distances. Term is also used for any electromechanical device that shows the track of a vessel or aircraft on a chart.

Plotting Sheet.
 A blank chart, usually on the Mercator projection, showing only the graticule and a compass rose. The meridians are usually unlabeled by the publisher so that these can be appropriate labeled when the chart is used in any longitude. Plotting sheets are often used in-lieu of charts when the vessel is off-soundings (in deep water). By using special tables, Loran-C LOPs can be drawn on plotting sheets.

Position.
 On the earth this refers to the actual geographic location of a vessel defined by two parameters called coordinates. Those customarily used are latitude and longitude. Position may also be expressed as a bearing and distance from an object, the position of which is known, or by loran TDs.

Position Line.
 See Line of Position.

Predictable Accuracy.
 Term meaning the same as absolute or geodetic accuracy.

Primary Phase Factor (PF).
 A correction to a Loran-C reading due to signal propagation through the atmosphere as opposed to propagation through free space. The speed of Loran-C signals through the atmosphere is equal to the speed through free space divided by the atmospheric index of refraction. This speed is taken as 2.99691162 times 10^8 meters per second.

Prime Meridian.
 The meridian from which longitude is measured both east and west; 0 longitude. It passes through Greenwich, England, and divides the earth into Eastern and Western Hemispheres.

Protractor.

An instrument for measuring angles on a surface, such as a chart. Typically a protractor is constructed of transparent plastic and has a semicircular scale measured in degrees.

Pulse Leading Edge.
 That portion of the Loran-C pulse between the beginning and peak.

Pulse Repetition Frequency or Rate (PRF, PRR).The average number of pulses per unit of time. For the Loran-C system, the PRF or PRR is the reciprocal of the GRI. Thus, a chain with a GRI of 50,000 usec would have a PRR of 20 Hertz.

Pulse Trailing Edge.
 That portion of the Loran-C pulse following the peak.

Radionavigation.
 The determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves.

Radionavigation System Parameters.
 Navigation systems described are defined in terms of system parameters which determine the use and limitations of the individual navigation systems signal in space. These parameters are:

Ambiguity
Accuracy
Availability
Capacity
Coverage
Fix Dimension
Fix Rate
Integrity
Reliability
Signal Characteristics
(See separate definitions of each term.)

Rate.
 Generic term sometimes used to describe a Loran-C LOP or family of LOPs from a given station pair. Nautical charts, for example, will identify the Rates shown, e.g., 9960-W, 9960-X, 9960-Y, 9960-Z, 7980-W, etc.

Reciprocal Bearing or Course.
 A bearing or course that differs from the original by 180 degrees.

Reciprocal Direction.
 Corresponding but reversed direction obtained by adding or subtracting 180 degrees to the reference direction.

Relative (R).
 See Relative Direction.

Relative Direction (Bearing).
 A direction relative to the fore-and-aft line of a vessel expressed in degrees and labeled R.

Reliability.
 The reliability of a navigation system is a function of the frequency with
which failures occur within the system. It is the probability that a system will
perform its function within defined performance limits for a specified period of
time under given operating conditions. Formally, reliability is one minus the
probability of system failure.

Remote Operating System (ROS).System developed by the U.S. Coast Guard to permit
remote-control of loran stations and reduce the manning requirements. ROS
consists of two individual sets of equipment:
(i) The local station operating set (LSOS) which is located at the transmitting
station, and

(ii) The remote site operating set (RSOS) which is located at the remote (or
control) station.

ROS permits the operation of a transmitting station to be controlled from a
remotely located station.

RHO-RHO (ranging mode).
 A mode of operation of a radionavigation system in which the times for the
radio signals to travel from each transmitting station to the receiver are
measured rather than their differences (as in the hyperbolic mode). This is
based upon the known correspondence of the transmission time to UTC. In
principle, Loran-C can be used in the RHO-RHO mode (see attached references),
but this requires special equipment not used by the typical user.

Root Mean Square (RMS).
 The square root of the arithmetical mean of the squares of a group of numbers.

Secondary Coding Delay (SCD or CD).
 Interval in micro-seconds between the reception of a loran signal at the
secondary station and the time when the secondary station transmits a signal in
the loran navigation system. Secondary coding delays are published for each
secondary station. Sometimes referred to simply as coding delay (CD).

Secondary Phase Factor (SF).
 The amount, in microseconds, by which the predicted time difference of a pair
of Loran-C signals that travel over an all seawater path differs from that of
signals that travel through the atmosphere. For distances, denoted D, of less
than or equal to 100 NM this SF is approximately:

SF = (0.00176)D + 0.510483/D - 0.011402,

for distances greater than or equal to 100 NM, this SF is approximately:

SF = (0.00346776)D + 24.0305/D - 0.40758.

Secondary Station.
 One of the two to five other transmitters in the Loran-C chain (designated V,
W, X, Y, and Z) that transmits a signal, keyed in time to that of the master,
used to compute a time difference. At one time, the secondary transmitter would
transmit (after an interval known as the secondary coding delay) only on receipt
of the master signal. These station's transmissions were controlled by the
master station and were called slave stations. Now, the secondary transmitters
maintain their own time standard, but the time of transmission relative to the

master signal is designed to be the same as before. Technically speaking the transmissions of secondary stations are now referenced to the master.

Service Area.
 See Coverage Area.

Set.
 The direction towards which the current is flowing expressed in degrees. This term is also commonly used to mean the direction towards which a vessel is being deviated from an intended course by the combined effects of external force such as wind and current.

Settling.
 Second step in the Loran-C receiver sequence of signal acquisition, settling, and tracking. In this step the Loran-C receiver automatically aligns the phase codes and identifies the standard zero crossing point to establish ground wave tracking. See Acquisition, Tracking.

SHF.
 See Chapter I, Table I-3.

SIGMA.
 See Standard Deviation.

Signal Characteristics.
 Signals in space are characterized by power levels; frequencies, signal formats, data rates, and any other information sufficient to completely define the means by which a user derives navigational information.

Signal-to-Noise Ratio (SNR).
 The ratio of the signal strength to that of the electronic noise (background) in a defined frequency spectrum. Loran coverage diagrams are calculated so that the SNR is at least 1:3, even though many receivers are capable of processing weaker signals. Signal-to-noise is sometimes expressed in decibels (dB). The SNR in decibels is mathematically equal to 20 log (SNR), so that an SNR of 1:3 works out to approximately -9.54 -- often rounded to -10.

Skywave.
 Skywave is an indirect radio wave that reflects off the ionosphere, rather than traveling a direct path from transmitter to receiver. Because these waves travel a different distance (in particular a longer distance), sky waves will give an erroneous TD reading in a loran receiver. The shape of the loran pulse and phase coding are used to attempt to minimize or eliminate the effects of skywave contamination.

Skywave Delay.
 The time interval between the arrival of the ground wave and the various skywave reflections. Typically, skywaves can arrive as early as 35 microseconds, or as late as 1,000 microseconds after the groundwave.

Slave Station.
 Term used with standard loran. See Secondary Station.

Small Circle.

Any plane passing through the earth, but not through its center, produces a small circle at its intersection with the earth's surface.

South Geographic Pole.
 A reference for specifying a position on the earth's surface, at the south end of the earth's axis. Also called True South Pole.

South Magnetic Pole.
 The end of the earth's magnetic core opposite the North Magnetic Pole. (Located in Antarctica.)

Spectrum Specification.
 The spectrum specification relates to the amount of energy allowed outside the authorized 90 to 110 kHz band. The maximum out of band energy is constrained to be no more than 1% of the total radiated energy, with subsidiary constraints than no more than 0.5% of the total radiated energy be less than 90 kHz nor greater than 110 kHz.

Speed (S).
 The rate at which a vessel advances relative to the water over a horizontal distance. When expressed in terms of nautical miles per hour, it is referred to as knots (kn or kt). One knot equals approximately 1.15 statute miles per hour.

Speed Curve.
 A curve relating the vessels speed through the water to the engines throttle setting expressed in revolutions per minute (RPM).

Speed LOP.
 An LOP situated at approximately right angles to the intended track, so named because the EP derived from this LOP provides a good indication of the vessels SMG.

Speed Made Good (SMG).
 Indicates the overall speed actually accomplished relative to the ground along the course line.

Speed of Advance (SOA).
 Indicates the speed intended to be made relative to the ground along the track line.

Speed Over the Ground (SOG).
 The actual speed made good at any instant in time with respect to the ground along the course being steered.

Speed Through the Water (STW).
 The apparent speed indicated by log-type instruments or determined by use of tachometer and speed curve or table, at a particular point in time, along the course line.

Speed-Time-Distance.
 A formula to calculate speed, time, or distance.

Spherical Coordinate System.
 The system used to define positions on the earths surface.

Standard Deviation (SIGMA).

A measure of the dispersion of random errors about the mean value. If a large number of measurements or observations of the same quantity are made, the standard deviation is the square root of the sum of the squares of deviations from the mean value divided by the number of observations less one.

Standard Sampling Point (SSP).
 In the calculation or measurement of Loran-C field strength it is necessary to specify the point on the pulse to which the calculation or measurement relates. This point is termed the standard sampling point and is the point on the Loran-C pulse envelope 25 microseconds after the beginning of the pulse. For the standard Loran-C pulse with zero ECD, the amplitude at the standard sampling point is 0.506 of the peak amplitude.

Standard Zero Crossing.
 The positive zero crossing at 30 microseconds of a positively phase coded pulse on the antenna-current waveform. This zero crossing is phase-locked to the Loran-C stations cesium reference. The standard zero crossing is used as a timing reference for measurement of Loran-C signal specifications.

Standardized Color Coding (Charts).
 Standardized colors used to show Loran-C lines of position on nautical charts. These color codes for the various secondaries in the loran chain are W=blue, X=magenta, Y=black, and Z=green.

Station-Pair.
 A master and secondary station in a Loran-C chain from which it is possible to derive an LOP.

System Ambiguity.
 System ambiguity exists when the navigation system identifies two or more possible positions of the vehicle, with the same set of measurements, with no indication of which is the most nearly correct position. See also Ambiguity.

System Area Monitor (SAM).See LORMONSITE.

System Capacity.
 System capacity is the number of users that a system can accommodate simultaneously. The Loran-C system could theoretically allocate an infinite number of users.

Tachometer.
 An instrument that indicates the speed of the engine measured in revolutions per minute (RPMs).

Theta.
 Bearing or direction to a fixed point to define a line of position.

Time Difference (TD).
 In the loran system, the time difference (in microseconds) between the receipt of the master and secondary signals.

Time To Go (TTG).
 Calculated time until the next waypoint is reached, obtained by dividing the distance to go by the groundspeed.

Timing of Secondary Pulse Groups.

The emission delays of secondary stations are selected to ensure that the following criteria are met within each chain wherever signals can be received:

(i)The minimum time difference between any secondary and master is 10,900 microseconds.

(ii)The minimum difference of any two time differences is 9,900 microseconds.

(iii)The maximum time difference is the GRI minus 9,900 microseconds.

Track (TR).
 The intended or desired horizontal direction of travel with respect to the ground. (Synonym: Intended Track, Trackline.)

Tracking.
 Process of moving towards a location by adjusting the heading to compensate for prevailing current so as to travel to the station in a straight line.

Tracking (Loran).
 The process of measuring time differences from an acquired master-secondary Loran-C pair. The signal-to-noise ratio required for tracking of a preidentified signal is generally less than that required for signal is acquisition. For this reason it is sometimes the case that a vessel that has already acquired a loran signal can continue to navigate with this signal although an identical receiver turned on may be unable to acquire the signal. This is the terminal phase in the sequence acquisition-settling-tracking.

True North Pole.
 The north end of the earth's axis. Also called North Geographic Pole. The direction indicated by 000 or (360) on the true compass rose.

True Rose.
 The resulting figure when the complete 360 direction system is developed as a circle with each degree graduated upon it, and with the 000 indicated as true north. Also called compass rose.

True South Pole.
 A reference for specifying a position on the earth's surface, at the sound end of the earth's axis. Also called South Geographic Pole.

Turning Bearing.
 A bearing on a charted object, measured in advance by the navigator, at which the vessel should turn to reach the next leg of the course.

Uncorrecting (A Magnetic Direction).
 Converting a true direction to equivalent magnetic or compass direction.

VHF. See Chapter I, Table I-3.

Variation.
 The angular difference between the magnetic meridian and the geographic meridian at a particular location.

Velocity Along Route (VAR).Alternate name for velocity made good.

Velocity Towards Destination (VTD).Component of vessel's velocity in the direction of the waypoint. (See Chapter IV.)

Velocity Made Good (VMG).
 Component of vessels ground speed in the direction of the waypoint in use. In general, VMG is less than or equal to the vessels ground speed. This will equal the ground speed, in the absence of current, whenever the vessel is on course and heading directly toward the waypoint. Many Loran-C receivers can display VMG.

Verification Survey.
 In order to ensure that Loran-C lattices printed on nautical charts are as accurate as possible, the Coast Guard, with assistance from the National Ocean Survey, has been conducting Loran-C verification surveys. The purpose of these surveys is to collect TD data. These data are then used to update and improve the accuracy of Loran-C lattices printed on previous editions of nautical charts.

Very High Frequency Radio (VHF).
 Radio frequency of 30 MHz to 300 MHz. The VHF system is essentially a line-of-sight system limited in range to only a little beyond the horizon. Early hyperbolic systems e.g., Gee, operated at these frequencies.

VLF.
 See Chapter I, Table I-3.

Waypoint (WPT or WYPT).
 Arbitrary geographic point entered into a loran set as a reference point for navigational calculations. Typically voyages are organized into a series of waypoints marking the legs of the trip. Most modern Loran-C receivers have provision for storing and recalling numerous waypoints.

Waypoint Sequencing (Route Option).
 A feature incorporated into many loran receivers that allows an operator to store a sequence of waypoints in the loran receivers memory to describe a route. In this mode, whenever the vessel arrives at a waypoint the next waypoint in a prestored route sequence automatically appears on the display screen.

World Geodetic System (WGS).
 A consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the center of mass of the earth, transformations from major geodetic datums, and the potential of the earth (usually in terms of harmonic coefficients).